

TITLE: Application of the V-Gamma Map to Vehicle Breakup Analysis

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ABSTRACT:

The history and evolution of the V-Gamma map software, its application to vehicle breakup analysis, and its utilization in the accidental Earth reentry analysis in Pluto New Horizons (NH) and Mars Exploration Rover (MER) missions are presented. The V-Gamma Map consists of all possible pairs of speed (V) and flight path angle (Gamma) at atmospheric entry interface for accidental out-of-orbit reentries resulting from steady misaligned burns, incomplete burns, or no burn (see Figure). The trajectories are categorized into six classes: hyperbolic escape, prompt elliptic reentry, delayed elliptic reentry, powered entry, decay of an initial ellipse, and prompt hyperbolic entry as presented first in the Reference. The probability of each category of atmospheric reentry or escape is also evaluated. The V-Gamma Map provides the initial speed and flight path angle at atmospheric entry interface, which are required inputs for the propagation and simulation of the descent trajectory for which vehicle breakup analysis is performed.

The original V-Gamma Map software as presented in the Reference has been reproduced in a MATLAB environment. Software design and implementation based on the functional requirements produced a user-friendly code. The manual post-processing in the original V-Gamma Map was also automated. The new V-Gamma Map software was validated and had been successfully applied to the Pluto NH and MER missions. In the vehicle breakup analysis of both missions, the V-Gamma Map was used as a pre-processor to provide the initial speed and flight path angle for out-of-orbit reentries, and points about the V-Gamma Map were considered in order to bound the possible reentry scenarios.

Reference: McRonald, A., "Galileo RTG Reentry Breakup Analysis", JPL D-1876, September 1984.

V-GAMMA Map

